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ABSTRACT

This paper reports the results of a survey of 1,200 teachers' views on technology. Using a combination of empirical methods, teachers' responses to statements about technology in contemporary society were examined. This paper describes the following: (1) new statements about technology based on the sociology of technology; (2) teachers' responses to these statements; and (3) teachers' responses compared to those of high school graduates and undergraduate science students. The paper speculates on the model of technology held by many teachers and offers suggestions for pre- and inservice education. A series of statement pairs (positive and negative exemplars) were designed to elicit teachers' responses to the issues of technology and quality of life, technology and employment, technology and health care, technology and food production, and technology and social well-being. The responses indicated that the teachers in this sample described and critiqued technology from an artifact perspective, that they were evenly split on whether technology improved employment prospects, that medicine was the example most often cited as an example of beneficial technology, and that a technocracy was favored by half the respondents. These results were indistinguishable from the responses of graduating high school seniors. A copy of the survey is included. (MVL)

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Information and Research Report

Teachers' Views of Technology: A Research Report

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A paper presented at the 62nd Annual Meeting of the National Association for Research in Science Teaching, San Francisco, CA, April 1, 1989

Teachers' Views of Technology:

A Research Report

Introduction

Describing technology and technological literacy has turned out to be a complex task. A comprehensive overview of issues and problems was the focus of a double issue of the Bulletin of Science, Technology & Society (1986). A close examination of this issue indicates that the task was not totally accomplished. Staudenmaier (1985) offers a thorough analysis of the perspectives on technology presented by papers in the journal Technology and Culture. Although these perspectives are of immense help to the theoretician, they were never written with the educational researcher in mind. Fleming (1988, in press) has offered a combination of a theoretical model of technology with its concomitant instructional implications. It was this model which served as the theoretical base for several aspects of the research described in this paper.

A significant volume of research does exist which describes students' views on technology. The views of high school graduates (Aikenhead, Fleming & Ryan, 1987; Aikenhead & Ryan, 1987) and the views of undergraduate science students (Fleming, 1988) have been explored. There are, however, very few research studies designed specifically to document teachers' views on technology. Lack of data in this area poses serious problems for those who wish, for example, to design pre-service and in-service programs for those teachers who must implement curricula with a technological literacy focus. It was this lack of data which prompted the research described below.

Purpose

The purpose of this research was to determine teachers' views on the nature of technology.

Design and Procedures

This study used survey research methods. A random sample of 1,200 teachers was drawn from the K-12 teaching population (N = 12,000). Each teacher in the sample was mailed the survey instrument (described below). After ten days, a reminder card was sent. 596 teachers (49.6%) completed and returned the survey.

The survey instrument

The instrument was comprised of three sections. The first section asked teachers to respond to the technology questions on the instrument, Views on Science-Technology-Society (VOSTS) form mc.3 (Aikenhead & Ryan, 1987). The second section asked teachers to offer short paragraph responses to sixteen newly-created statements about technology arising from the literature in the sociology of technology. The teachers were randomly assigned to four sub-groups for this section. Each sub-group received four of the new statements. The research cited earlier had found for the analysis of written argumentative responses, theoretical saturation was reached by or prior to the thirtieth response. A response rate of 50% ensured a maximum of 150 responses for each statement. The non-usable responses are tabulated in the analysis section; and were so small as to guarantee a large number of paragraphs for analysis for each statement. The third section asked for demographic information.

Analytical procedures

The VOSTS results were analyzed using SPSS-X to generate response

profiles for each statement on the instrument. The written responses were analyzed according to the method of Aikenhead, Fleming & Ryan (1987). Combining the demographic data and the response profiles, Pearson correlation coefficients were calculated to determine whether there were relationships between VOSTS responses and gender, age, years of teaching experience, subjects taught, school size, and pre-service science education.

Results

The results are presented in four sections. Section A summarizes the demographic data, Section B presents the VOSTS results, Section C presents the results of the analysis of the argument responses, and Section D the analysis of the VOSTS/demographics interactions.

A. The demographic data (N = 596). These data are presented in Table 1.

TABLE 1. Demographics of the Respondents

Gender

Female	58%
Male	42%

Median Age

38 years

Median years of teaching experience

13 years

Division Mainly Taught

Fewer than 100	9%
Division I	27%
Division II	22%
Division III	15%
Division IV	30%
Other	6%

Student Population of School

Fewer than 100	9%
100 - 250	38%
250 - 500	33%
500 - 750	11%
750 - 1000	5%
1000 - 1250	2%
More than 1250	2%

Education in any physical sciences

No	67%
Yes	33%

As the reader is well aware, attention must be paid to the representativeness of the respondents vis-a-vis the sample and population. The population data for teachers shows a median age of 38 years, with the median years of teaching experience at 13 years. This is identical to the figures for the respondents. As well, the gender percentages and student population percentages closely reflect the population parameters.

B. Results of the analysis of the VOSTS statements

1. Science, Technology, and the Quality of Life: VOSTS 12.1 and 6.1

These data are presented in Tables 2 and 3. VOSTS 12.1 requires that the respondent differentiate between science and technology and use this differentiation when responding. 72% of the responses cluster around two items: D and E. Position D offers a contemporary view of the nature of the relationship between science and technology. Position E posits a functionalist role for science in which science directly benefits society through "medical and environmental advances." Given the small number of responses to item F, one could infer that "science" in item E is interpreted as "technoscience", a finding reported in earlier studies (Fleming, 1987) with high school graduates.

VOSTS 6.1 moves from the more general issues raised in 12.1 to specific quality of life issues. Once again, a clear understanding of the nature of science and the nature of technology is required. As can be seen from Table 3, half the respondents offer a democratic view of science and technology under the wise control of people. 29% of respondents confuse the role of science and technology. This confusion can be examined in the light of the data in the next two tables.

TABLE 2

VOSTS 12.1 In order to improve the quality of living in Canada, it would be better to invest money in technological research RATHER THAN scientific research.

Teacher position	% of Usable Responses
A. Invest in technological research because it will improve production, economic growth, and unemployment. These are far more important than anything that scientific research has to offer.	1
B. There is really no difference between science and technology.	0
C. Scientific knowledge is needed to make technological advances.	10
D. They interact and complement each other equally. Technology gives as much to science as science gives to technology.	26
E. Each in its own way brings advantages to society. For example, science brings medical and environmental advances, while technology brings improved conveniences and efficiency.	46
F. Invest in scientific research — that is, medical or environmental research — because these are more important than making better appliances, computers or other products of technological research.	3
G. Invest in scientific research because it improves the quality of life (e.g., medical cures, answers to pollution, and increased knowledge). Technological research, on the other hand, has worsened the quality of life (e.g., social welfare, education, job creation programs, the fine arts, foreign aid, etc.).	2
H. Invest in neither. The quality of living will not improve with advances in science and technology, but will improve with investments in other sectors of society (e.g., social welfare, education, job creation programs, the fine arts, foreign aid, etc.).	3
I. I don't understand.	0
J. I don't know enough about this subject to make a choice.	4
K. None of these choices fit my basic viewpoint	5

TABLE 3

VOSTS 6.1 Science and technology offer a great deal of help in resolving such social problems as poverty, crime, unemployment, over-population, and the threat of a nuclear war.

Teacher position	% of Usable Responses
A. Science and technology can certainly help to resolve these problems. The problems could use new ideas from science and new inventions from technology.	4
B. Science and technology can help resolve some social problems but not others.	6
C. Science and technology solve many social problems, but science and technology also cause many of these problems.	29
D. It's not a question of science and technology helping, but rather it's a question of people using science and technology wisely.	50
E. It's hard to see how science and technology could help very much in resolving these social problems. Social problems concern human nature; these problems have little to do with science and technology.	6
F. Science and technology only make social problems worse. It's the price we pay for advances in science and technology.	1
G. I don't understand.	0
H. I don't know enough about this subject to make a choice.	1
I. None of these choices fit my basic viewpoint.	3

2. The Relationship Between Science and Technology: VOSTS 11.2, 11.3 & 39

VOSTS 11.2 (Table 4) offers insight into the practical definition(s) of technology offered by the respondents. For all intents and purposes, there are three positions. The first, item B, views technology as applied science. It has been argued elsewhere (Barnes & Edge, 1982) that this is an untenable position. The second, item C, sees technology as know-how and artifacts. This restricted meaning for technology (Fleming, 1987; 1988 in press) will be seen again in the analysis of arguments in Section 3. In all, 52% of the respondents hold an incorrect or inadequate view of technology. The final group (27%) opt for item I, a position much closer to the view of technology called sociotechnology, in which technology is seen as a social process.

VOSTS 11.3 explores the nature of the relationship between science and technology. As argued earlier (Fleming, 1987), unless specifically asked to do so, people do not differentiate between the two enterprises. This was the case in VOSTS 12.1, where technoscience reigned. The current item had the strongest unanimity of answers. As can be seen in Table 5, 87% of the sample chose item B, which presents a reciprocity between science and technology.

VOSTS 39 opens a new domain, research and development. There are theoretical differences between "science and technology" and "research and development" (Ziman, 1984). As well, research and development are current catch phrases in Canadian media. As can be seen from Table 6, there is a wider range of responses to this item. The dominant position is item C. It appears that social utility is the key point to the "D" in "R & D." Notice as well that only 13% of the respondents viewed R & D as a "combination of science and technology." Yet, it could be argued that with a careful delineation of the nature of science and the nature of technology, C and F

TABLE 4

VOSTS 11.2 Defining what technology is, can cause difficulties because technology does many things in Canada. But MAINLY technology is:

Teacher positions	% of Usable Responses
A. Very similar to science.	0
B. The application of science.	26
C. New processes, instruments, tools, machinery, appliances, gadgets, computers, or practical devices for everyday use.	26
D. Bombs, military hardware, nuclear reactors, etc.	0
E. Robotics, electronics, computers, communication systems, automation, etc.	4
F. A technique for doing things.	5
G. A way of solving practical problems.	2
H. Inventing, designing and testing things (e.g., artificial hearts, computers, space vehicles).	4
I. Ideas and techniques for designing and manufacturing things, for organizing workers, business people and consumers, for the beneficial progress of society.	27
J. I don't understand.	0
K. I don't know enough about this subject to make a choice.	1
L. None of these choices fit my basic viewpoint.	6

TABLE 5

VOSTS 11.3 Science and technology are closely related to each other.

Teacher position		% of Usable Responses
A.	Science is the basis of all technological advances; though it's hard to see how technology could aid science.	1
B.	Scientific research leads to practical applications in technology, and technological developments increase the ability to do scientific research.	87
C.	Although they are different, they are linked so closely that it's hard to see how science could aid technology.	4
D.	Technology is the basis of all scientific advances; though it's hard to see how science could aid technology.	1
E.	Science and technology are essentially the same thing.	1
F.	I don't understand.	0
G.	I don't know enough about this subject to make a choice.	2
H.	None of these choices fit my basic viewpoint.	3

argue the same position.

Several other VOSTS items were also included in the survey. They dealt mainly with the role of scientists. For the sake of brevity in this paper, the findings can be summarized as showing the view that scientists help make the world a better place in which to live.

C. Results of the analysis of the argument responses

As mentioned earlier, 16 new statements based in the sociology of technology were used with sample sub-groups. These are found in part two of the questionnaire (Appendix A). The format of the statements and the analysis of the written arguments has been described earlier (Aikenhead, Fleming, & Ryan, 1987). One critical comment is important here. The VOSTS 11.2 results, which indicate the definitions of technology offered by the respondents, are reflected in their argument responses. Specifically, the overwhelming response to most of the statements was to reason with artifacts. Simply put, for many, the name of an artifact - microwave oven, VCR, satellite TV - was used as a replacement for a reasoned argument.

Because of space limitations, only a few representative resonse patterns have been presented. For example, the responses to the statement "Because of technology, my statement of living continues to improve", fell into two camps. One minority (15%) chose to offer arguments based on improved quality of life. A second minority (5%) argued it was one's finances, rather than technology, that determines one's standard of living. The majority (80%) resonded with the name of an artifact. The arguments took the form "Yes it has, think of the _____", where the blank can be filled in with a specific artifact. For this item, 32 artifacts were named.

TABLE 6

VOSTS 39 Science and Technology are important to the research and development (R & D) in Canadian industry. What does research and development mean to you?

Teacher position	% of Usable Responses
A. R & D means finding new answers to questions about the world and about people.	3
B. R & D means progress by making life easier and the quality of life better.	2
C. Research is exploring for new facts, ideas and information. Development is putting them to use in order to benefit society.	35
D. Research is exploring for new facts, ideas and information. Development is putting them to use by coming up with new and creative ideas.	19
E. R & D means exploring new ideas and problems in industry, in order to help an industry overcome its problems and thereby produce newer and better products.	5
F. R & D means a combination of science and technology. Research leads to development, and develoment leads to improved research.	13
G. R & D means helping humanity by finding medical cures and new technologies. But unanticipated effects of R & D can also cause social problems.	5
H. R & D usually means helping humanity by finding medical cures and new technologies. But R & D also means harming society by creating such things as nuclear arms and other wasteful or unhealthy technologies. It depends on the R & D or how it is used.	17
I. I don't understand.	0
J. I don't know enough about this subject to make a choice.	1
K. None of these choices fit my basic viewpoint.	2

When the negative statement was used - "Because of technology, my standard of living is not improving" -- the number of respondents "reasoning with artifacts" incrased to represent 93% of the respondents.

When subjects were asked to resopnd to statements about specific technologies - medical technology and agricultural technology in this case - the "reasoning by artifact" process again dominated, with over 90% of the respondents doing so.

The following two tables, Tables 7 and 8, present the data offered in response to two related positions:

a) Technological changes result in social changes — Table 7

b) Social changes result in technological changes — Table 8

Table 7 is representative of all the "reasoning by artifact" responses just described.

TABLE 7. Technological changes result in social changes.

Teacher Position	% of Usable Responses
A. My lifestyle relies on technology (16 artifacts are named, including the computer, word processor, automated tellers, and computerized axle flow combines)	83%
B. There is an improved quality of life (leisure time)	4%
C. Demographic patterns change	9%
D. The structure of the family unit has changed	3%
E. Non-usable	1%

In Table 8, the issue of social change during technological change is raised. It appears this statement prompts the respondents to leave their artifacts behind and come to grips with the idea of social change.

TABLE 8. Social changes result in technological changes.

Teacher position	% of Usable Responses
A. Societies needs and demands dictate the direction technology takes. (Note: 12 needs and demands were identified, including curing illness, mass transportation, home security systems, and time-saving devices)	77%
B. The two are interdependent	7%
C. I believe the reverse is true	12%
D. Social change doesn't have to result in technological change	1%
E. Non-usable responses	3%

D. The VOSTS/Demographics Interactions

There were no significant relationships found between VOSTS responses and gender, age, years of teaching experience, subjects taught, school size, and pre-service science education.

Discussion

The data strongly suggest that the teachers in this study have an inadequate understanding of technology. This has two related implications. First, in choosing materials for classroom use, teachers will choose those materials which most closely echo their own understanding. If the understanding is restricted, so will be the materials chosen. Second, these

results suggests that most teachers will teach students either that technology is applied science or that technology is artifacts. This will cause serious difficulties for those school jurisdictions attempting to implement STS-type science programs which reflect a sociotechnology perspective.

One hastens to add that this is not the teachers' fault. Regardless of their pre-service education, these teachers hold a consistent view on technology and its social role. One suspects, as does Nelkin (1986), that the media have a powerful impact on our views of technology and science.

The implications for pre-service education are obvious. Courses in the sociology of science and of technology should be mandatory for prospective educators. Content knowledge in these areas must be offered, particularly to assist teachers in choosing materials. Teaching methods for STS courses must also become a part of the prospective teachers repertoire. Both the content and the methods should be offered by faculties of education.

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Appendix A

The Survey Instrument, Part 2

Instructions for Part Two

For each of the following statements, tell whether you agree with the statement, disagree with the statement, or can't tell. Regardless of your response, write a brief response in the space provided in which you explain the reason(s) for your choice.

Statement B-1

A country's well-being relies heavily on investment in high technology.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-2.1

Most employment opportunities in the next 15 years will arise in high technology areas.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-3

Technological development occurs when a more sophisticated machine replaces a simpler one.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-4.1

Because of technology, my standard of living continues to improve.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Instructions for Part Two

For each of the following statements, tell whether you agree with the statement, disagree with the statement, or can't tell. Regardless of your response, write a brief response in the space provided in which you explain the reason(s) for your choice.

Statement B-2.2

Most employment opportunities in the next 15 years will not arise from high technology.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-4.2

Because of technology, my standard of living is not improving.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-5.1

Advances in medical technology have improved the quality of health care.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-6.1

Advances in agricultural technology have improved farming.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Instructions for Part Two

For each of the following statements, tell whether you agree with the statement, disagree with the statement, or can't tell. Regardless of your response, write a brief response in the space provided in which you explain the reason(s) for your choice.

Statement B-5.2

Medical technology has not improved the quality of health care.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-6.2

Advances in agricultural technology have not improved farming.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-7.1

Technological changes result in social changes.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-8.1

Technological developments are beyond the control of the average citizen.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Instructions for Part Two

For each of the following statements, tell whether you agree with the statement, disagree with the statement, or can't tell. Regardless of your response, write a brief response in the space provided in which you explain the reason(s) for your choice.

Statement B-7.2

Social changes result in technological changes.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-8.2

The average citizen can help control technological developments.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-2.1

Most employment opportunities in the next 15 years will arise in high technology areas.

___ Agree

___ Disagree

___ Can't tell

Reason for choice:

Statement B-3

Technological development occurs when a more sophisticated machine replaces a simpler one.

___ Agree

___ Disagree

___ Can't tell

Reason for choice: